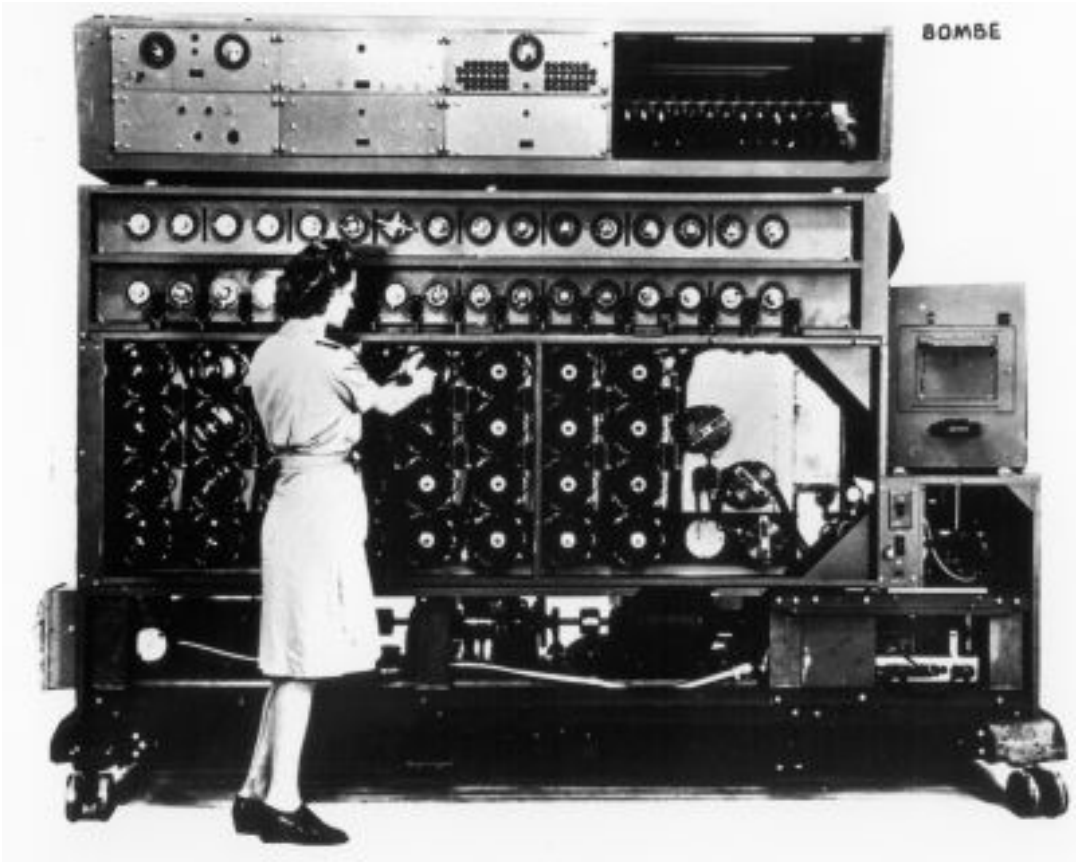

Introduction

http://www.mimuw.edu.pl/~inga/SO2019

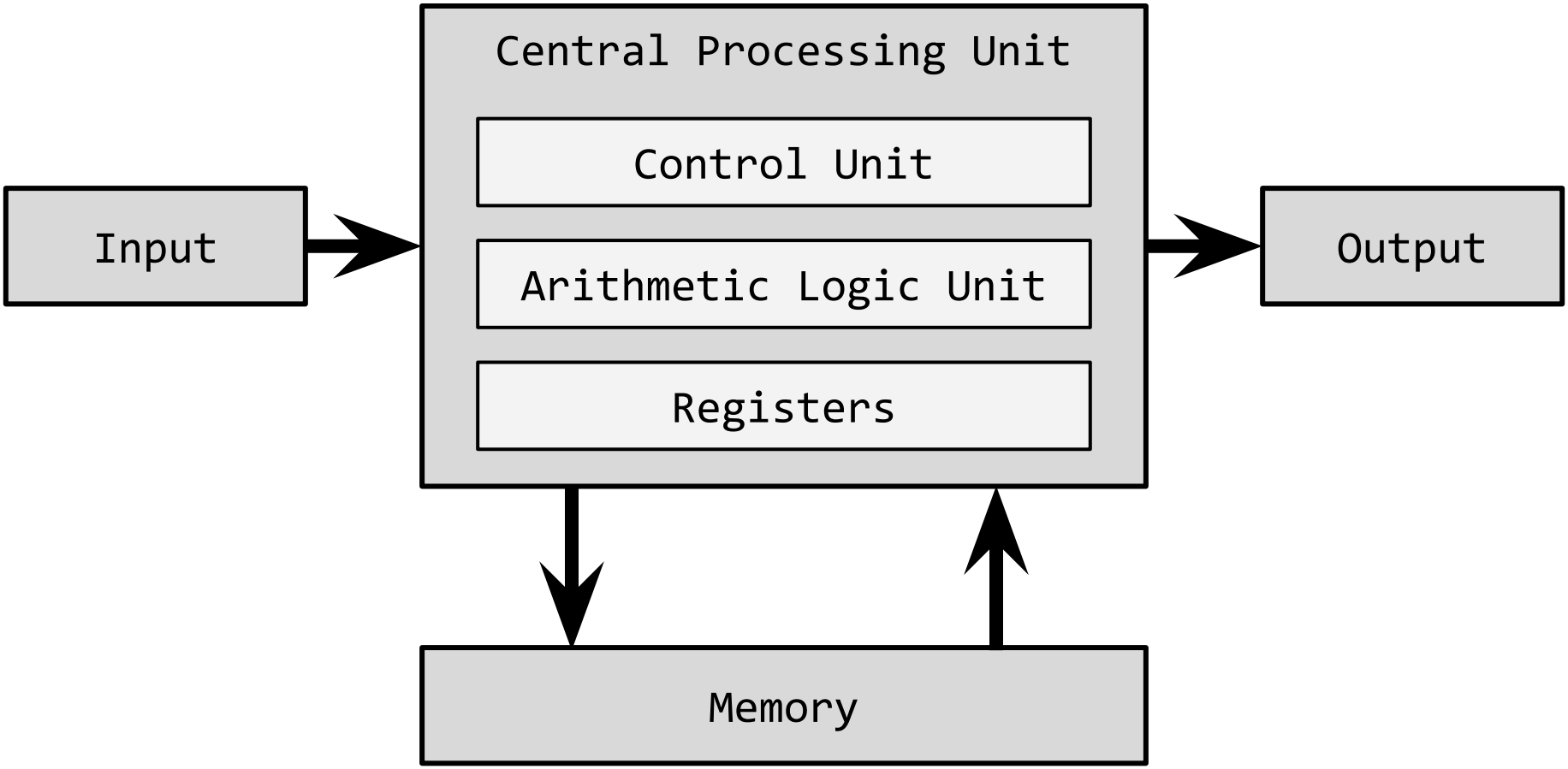
/home/students/inf/PUBLIC/SO**/scenariusze**

/home/students/inf/PUBLIC/SO**/zadania**

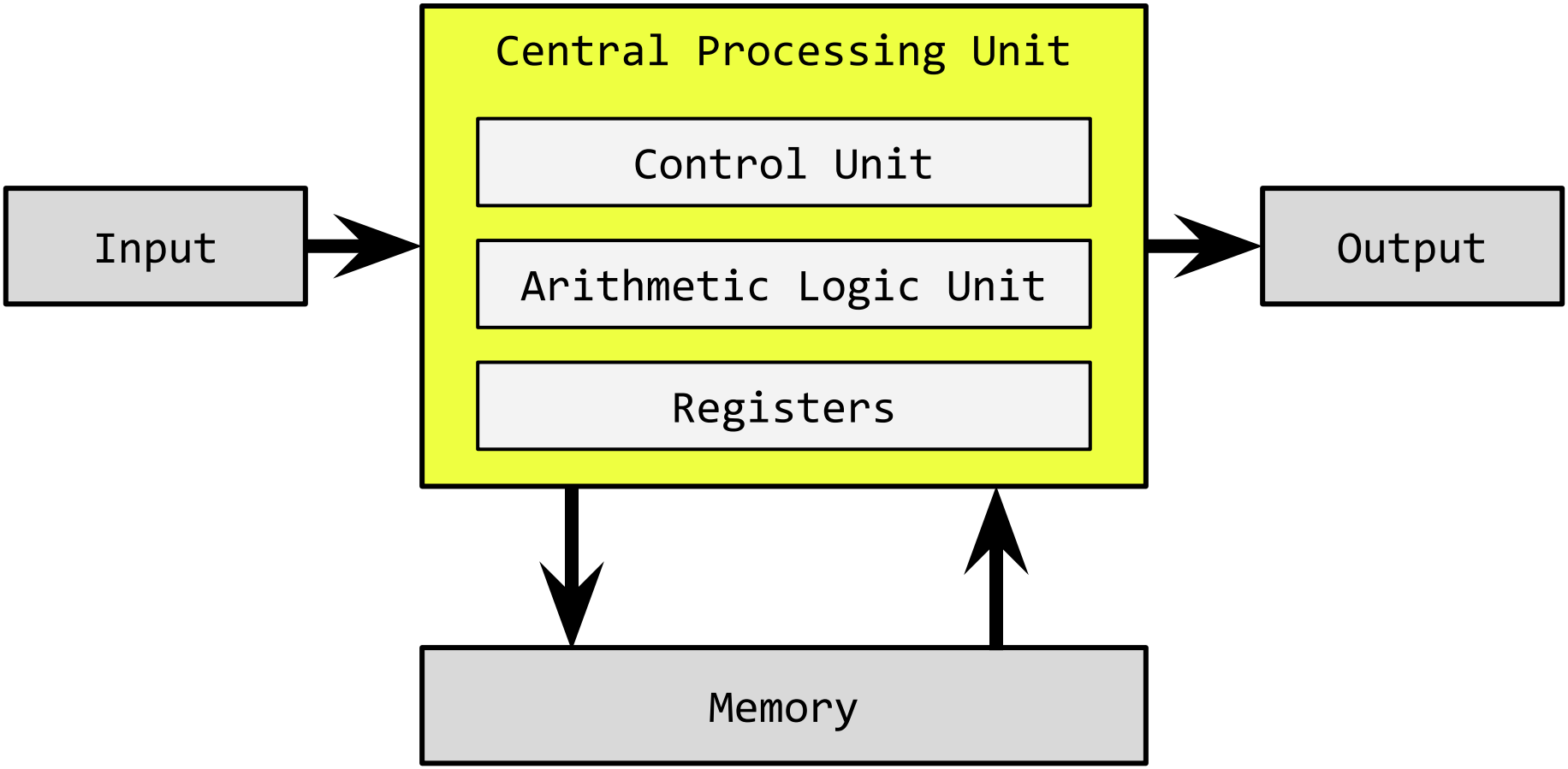

CURTA


BOMBE

Computer Architecture



Computer Architecture



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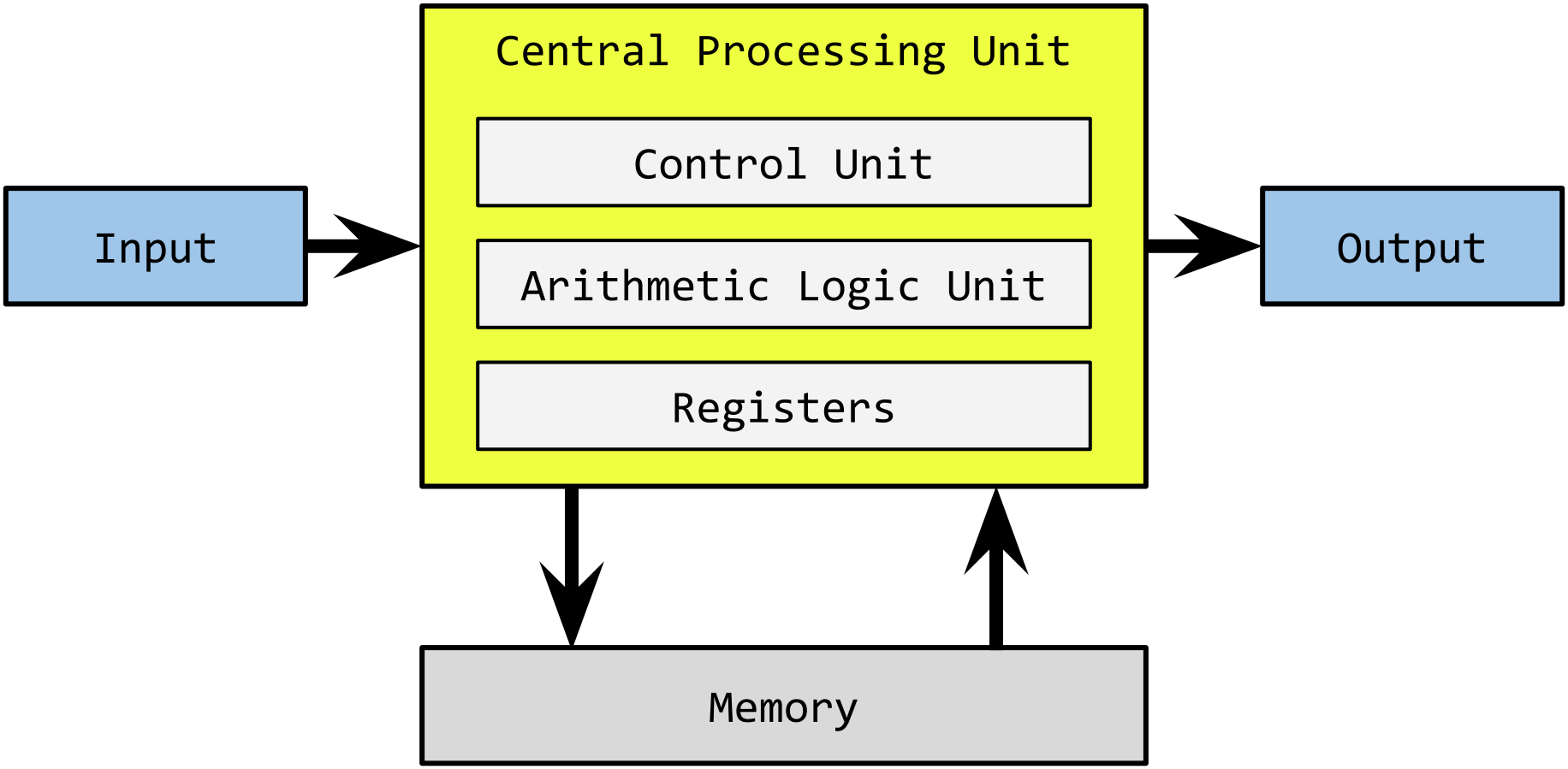

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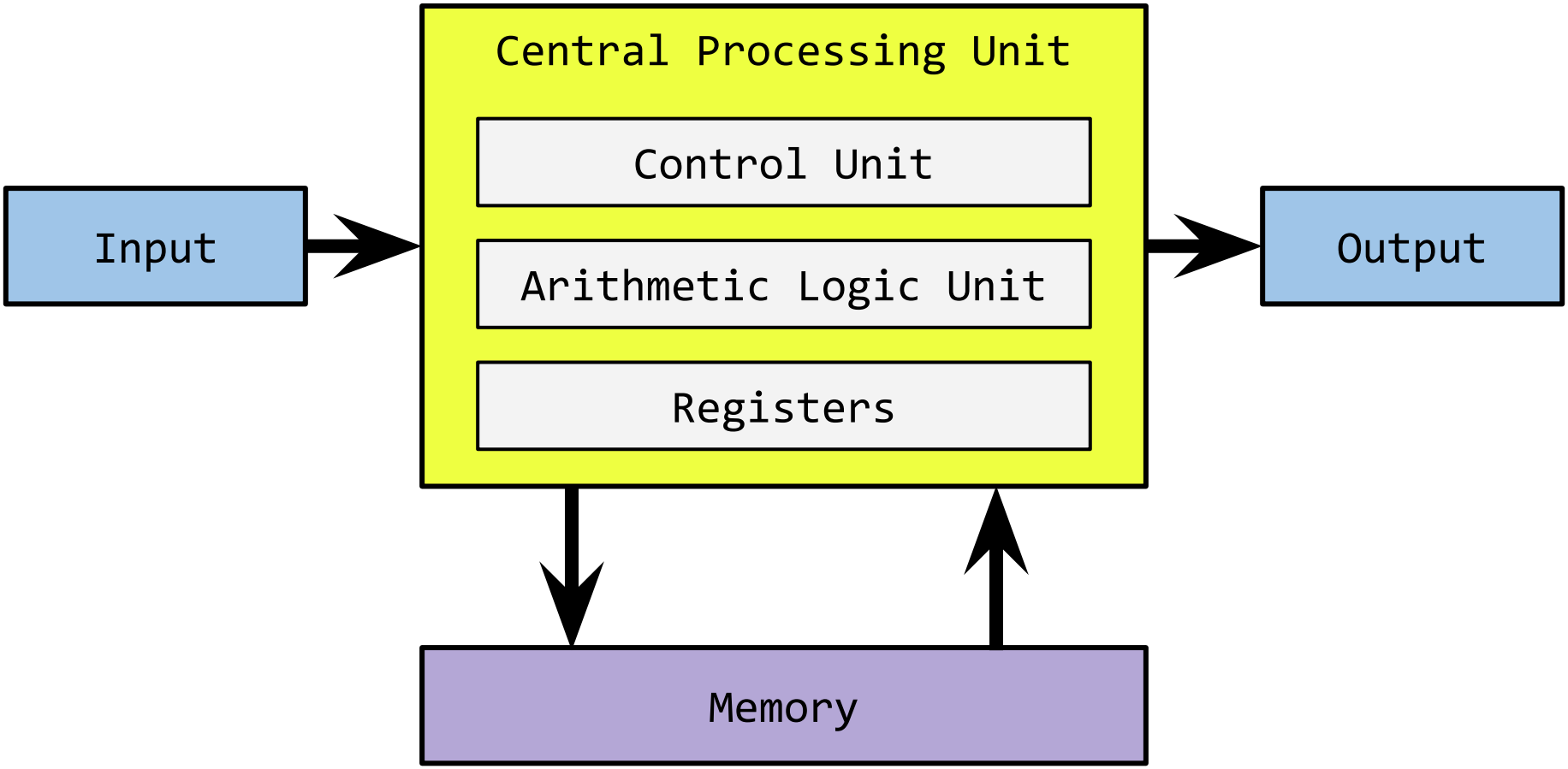

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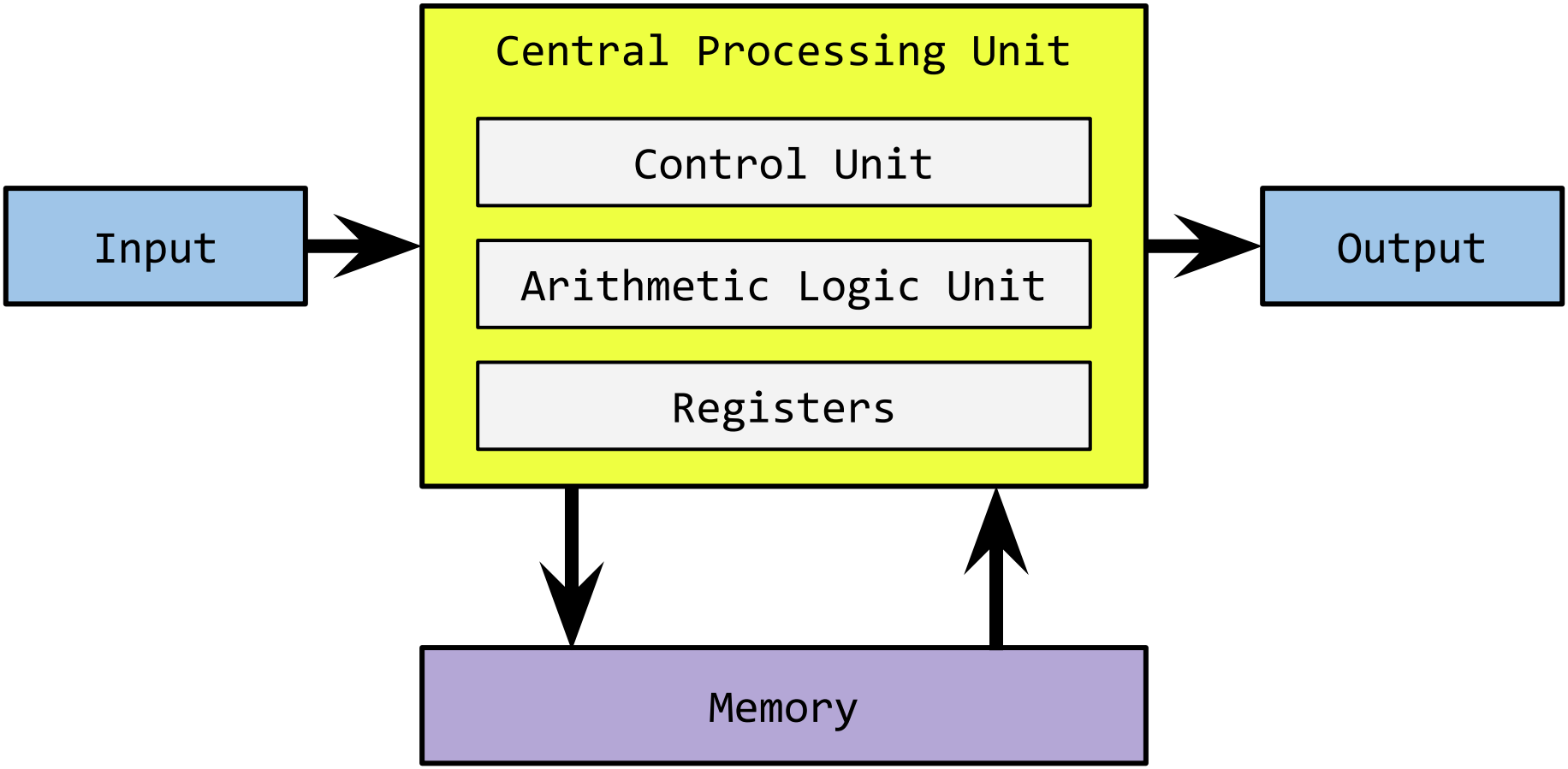


The Princeton Architecture

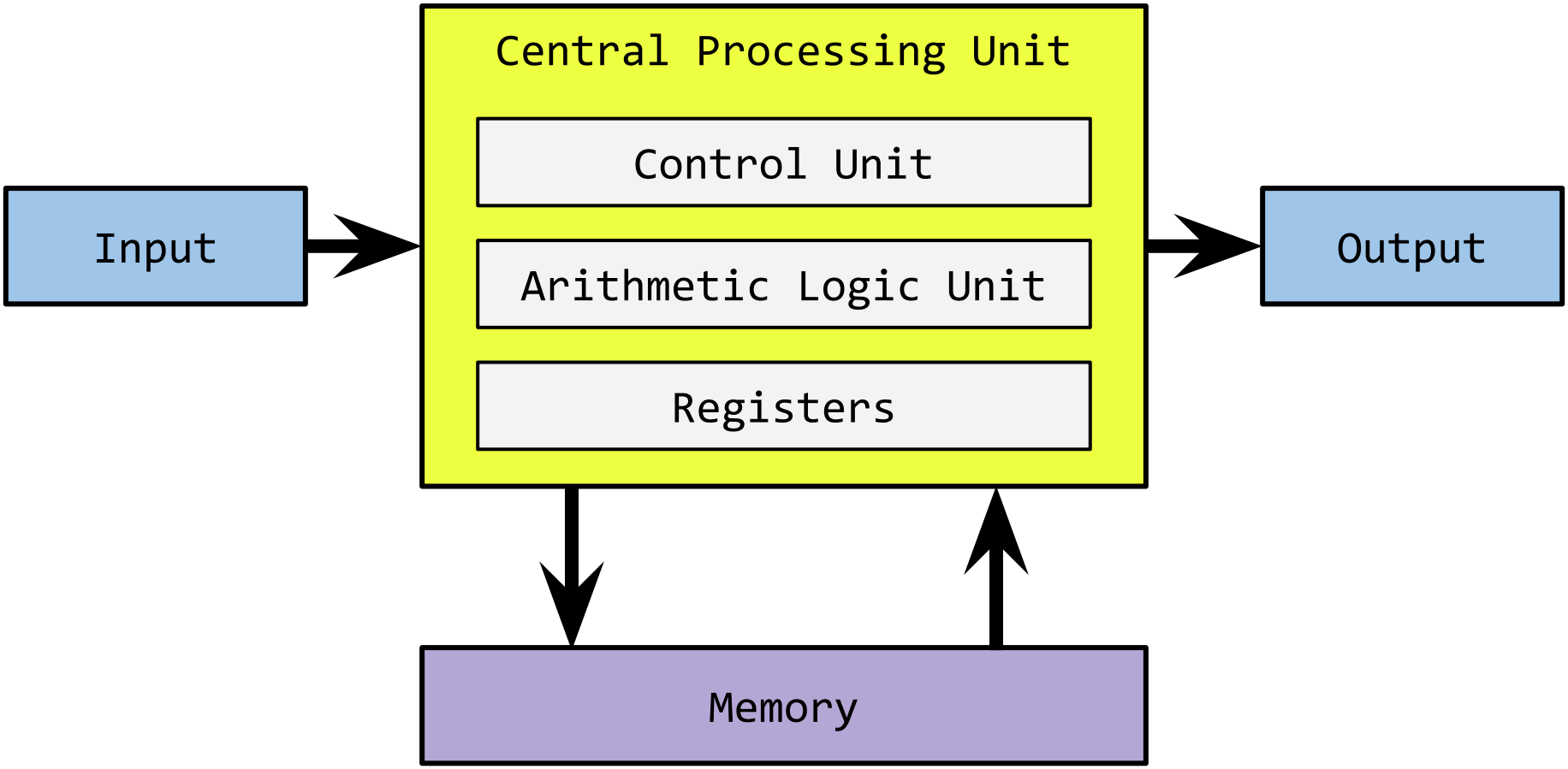
The Princeton Architecture

Alan Turing

Presper Eckert & John William Mauchly

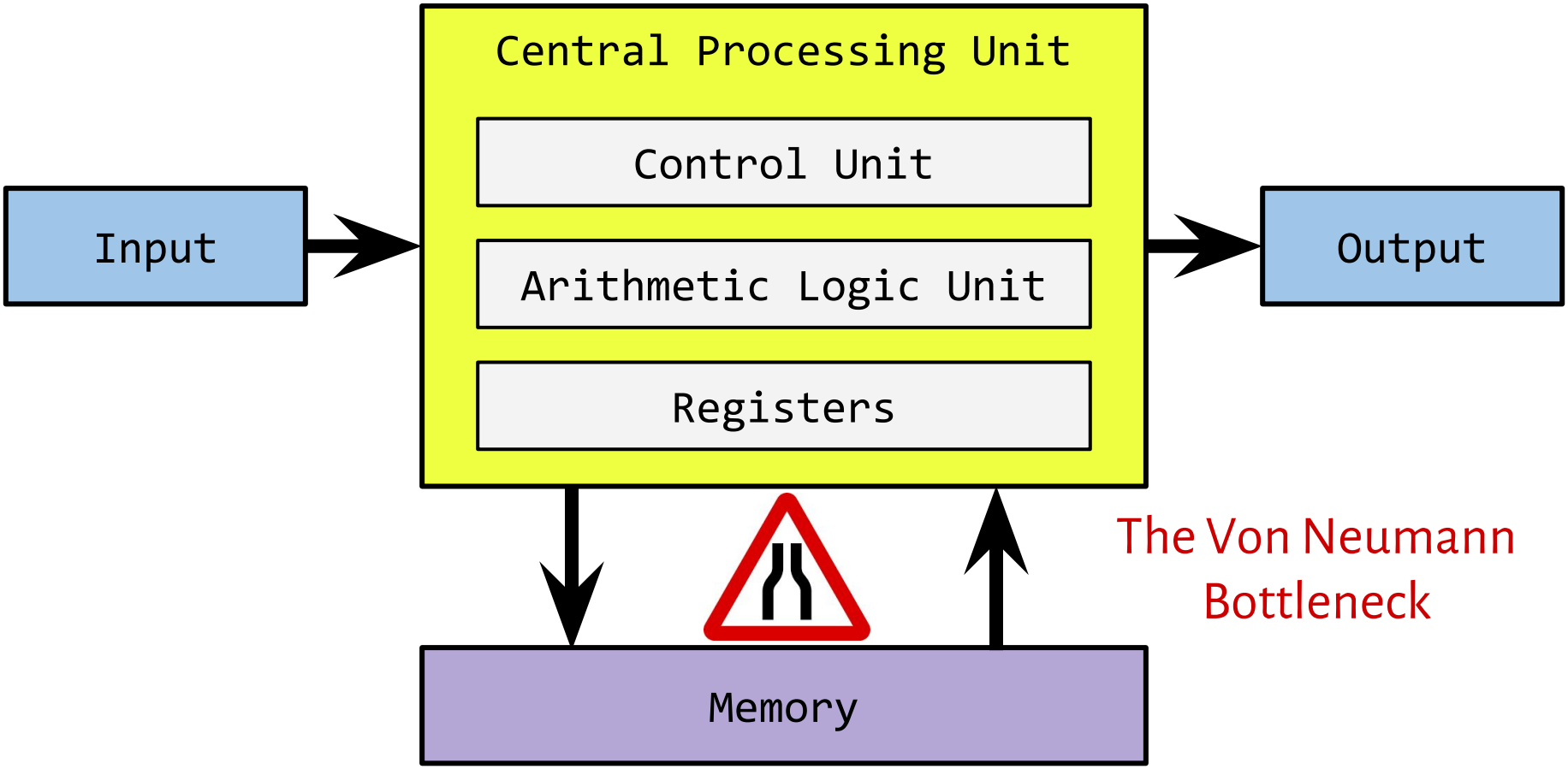
John von Neumann

Computer Architecture



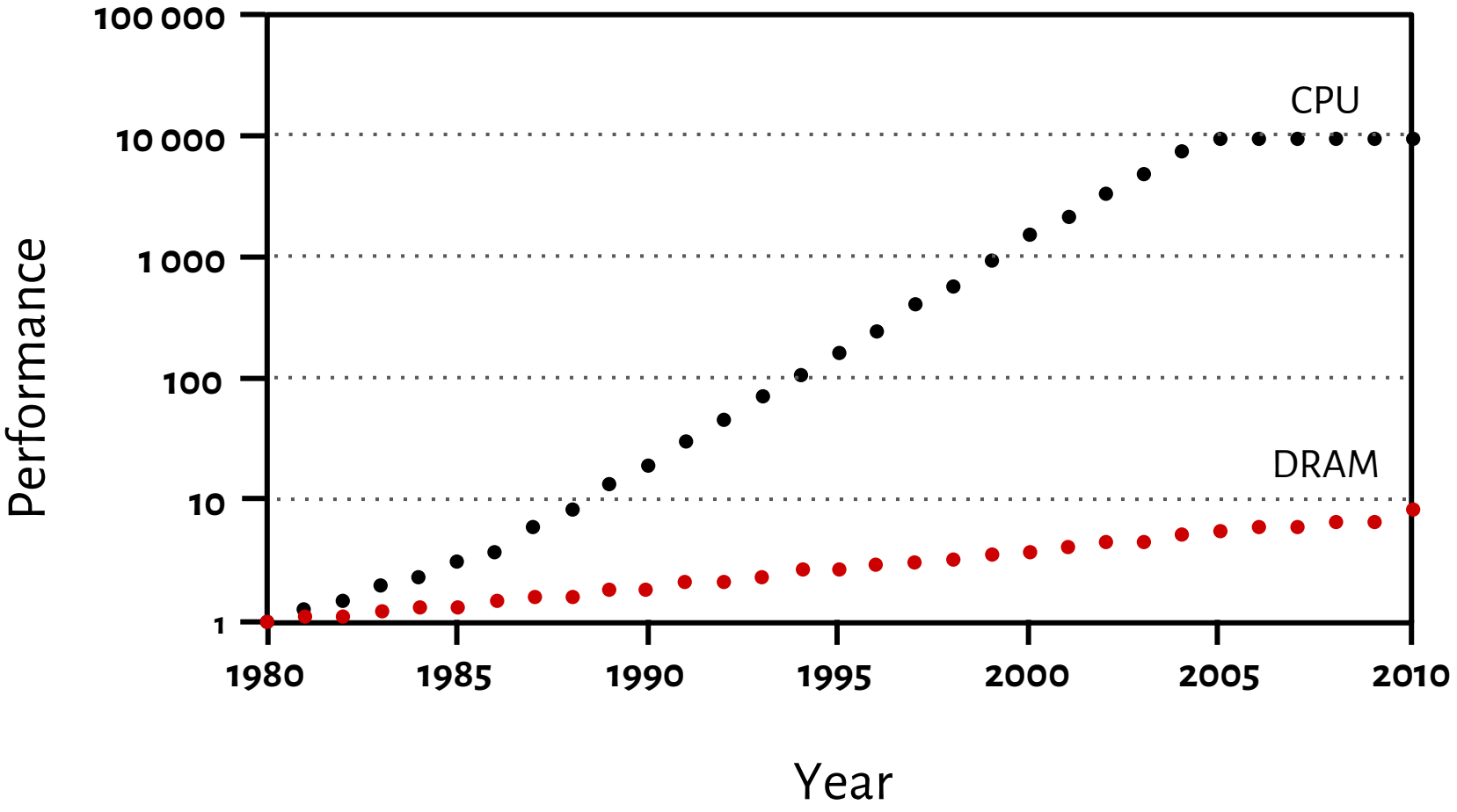
The Von Neumann Architecture

Computer Architecture



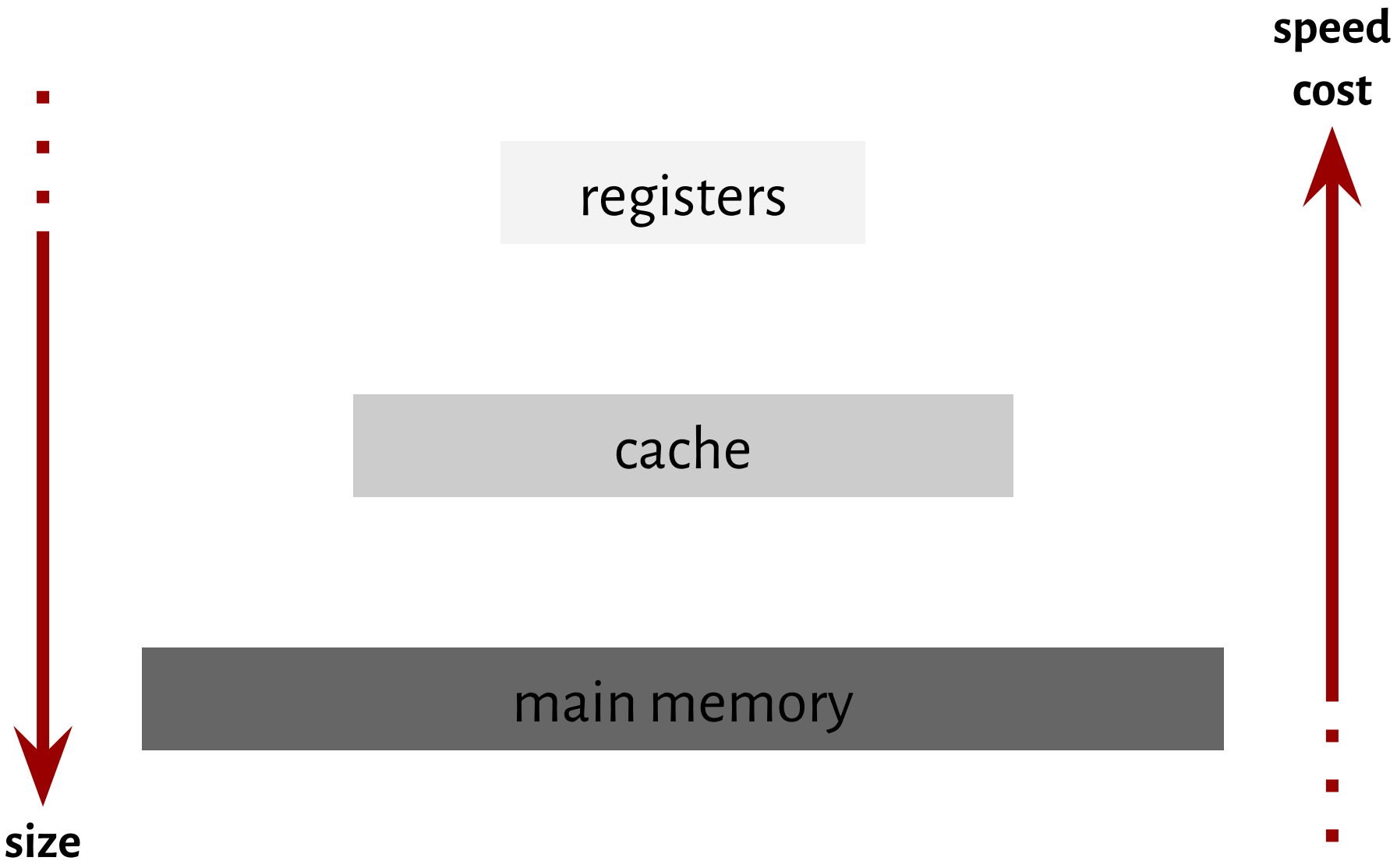
The Von Neumann Architecture

Memory-access bottleneck

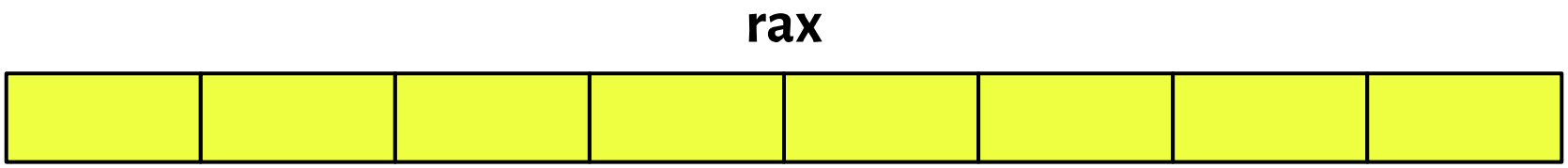


J. L. Hennessy, Stanford University and D. A. Patterson, University of California, Berkeley: *Memory Hierarchy Design*, 2012

Memory hierarchy



General Purpose Registers



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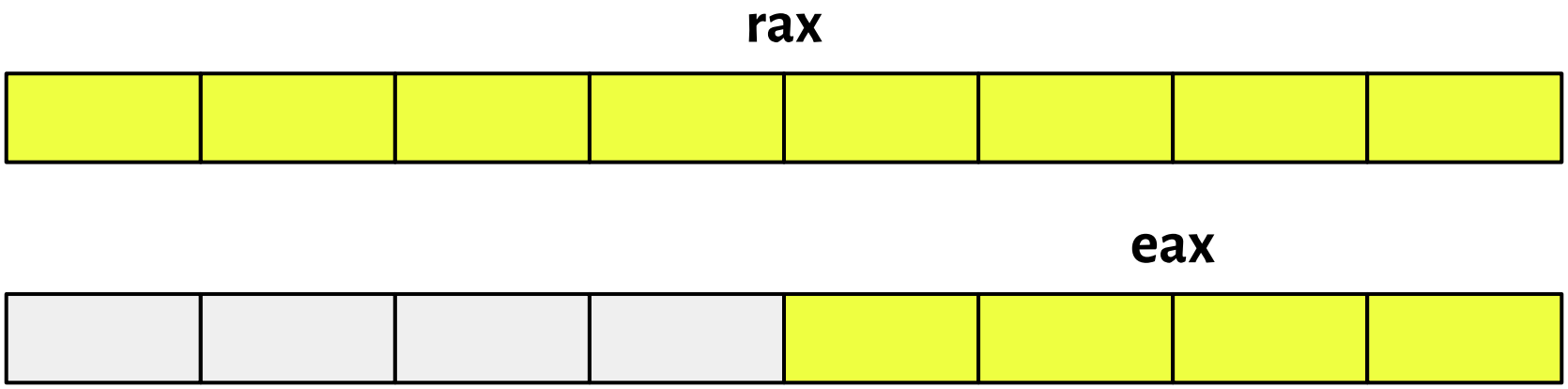

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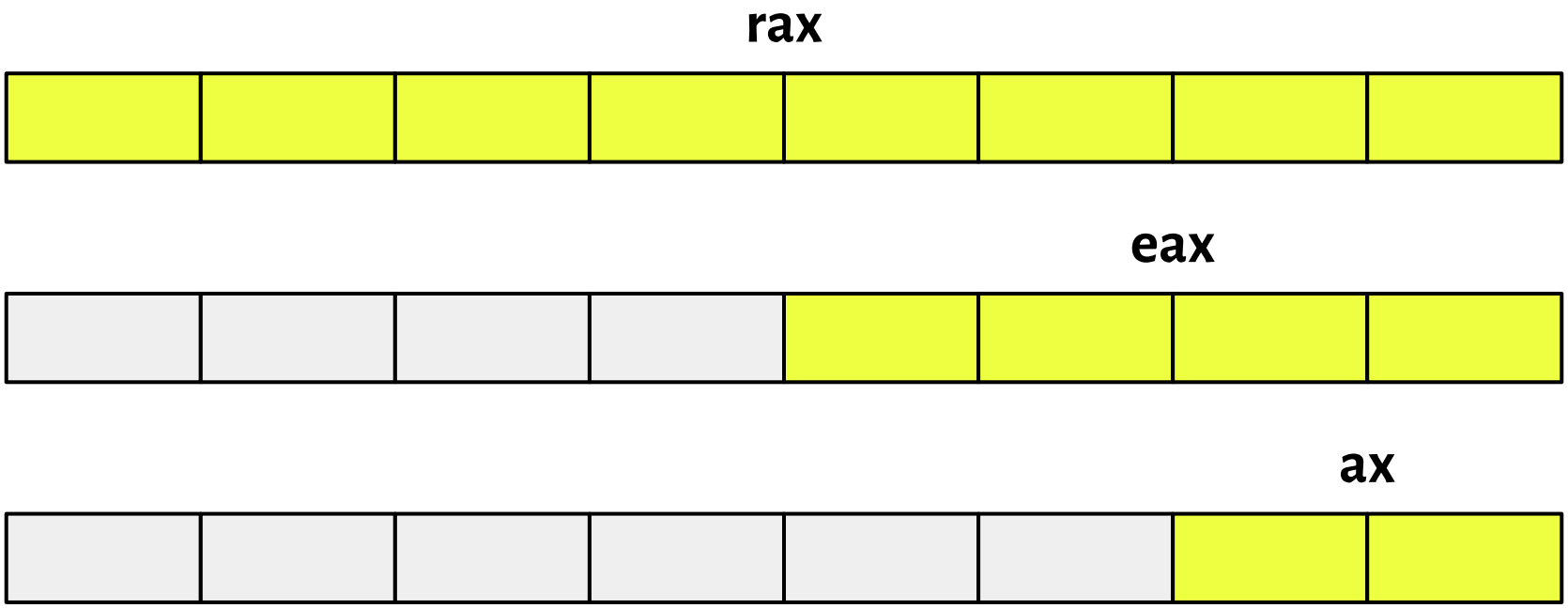

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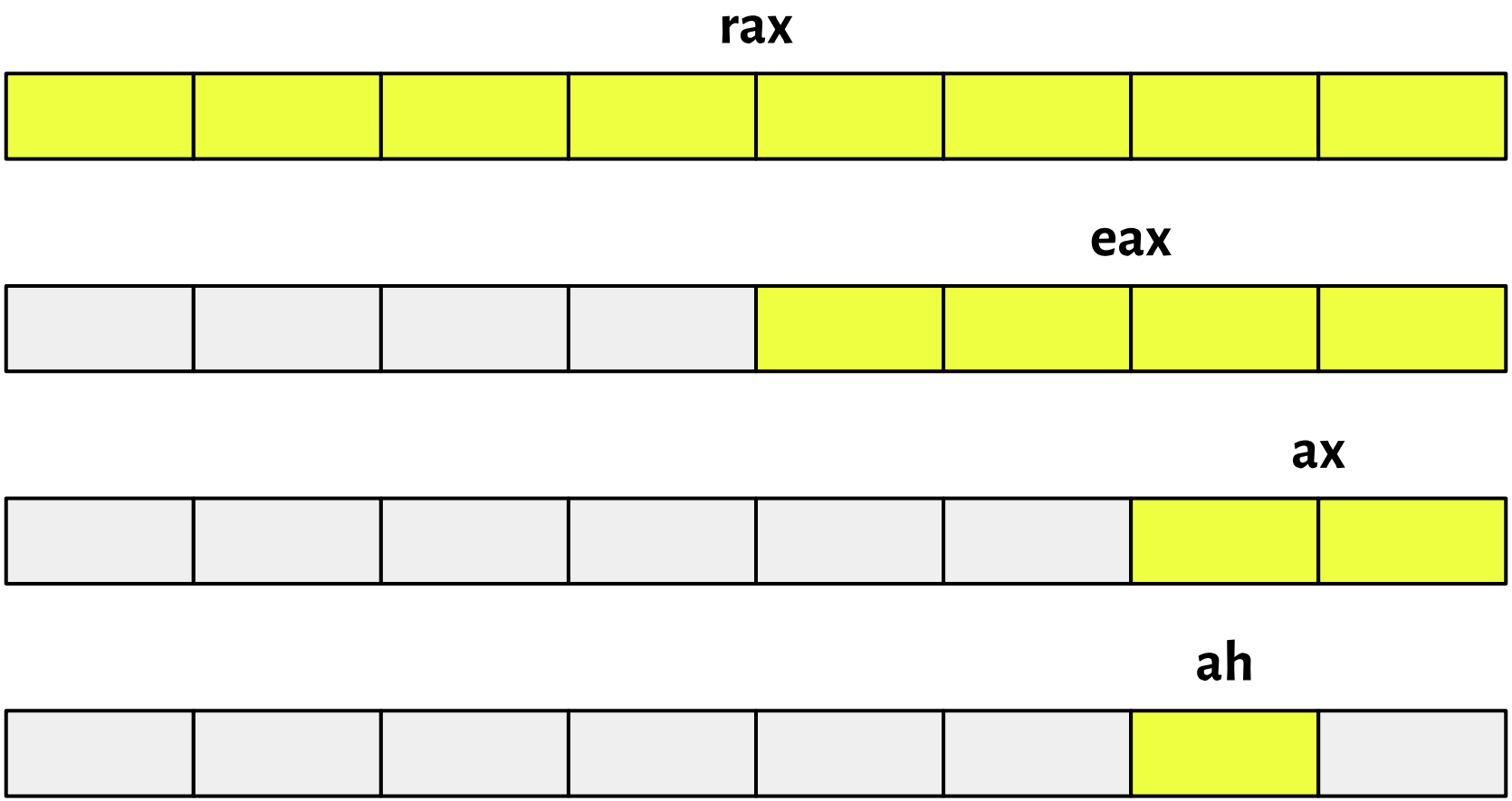

General Purpose Registers

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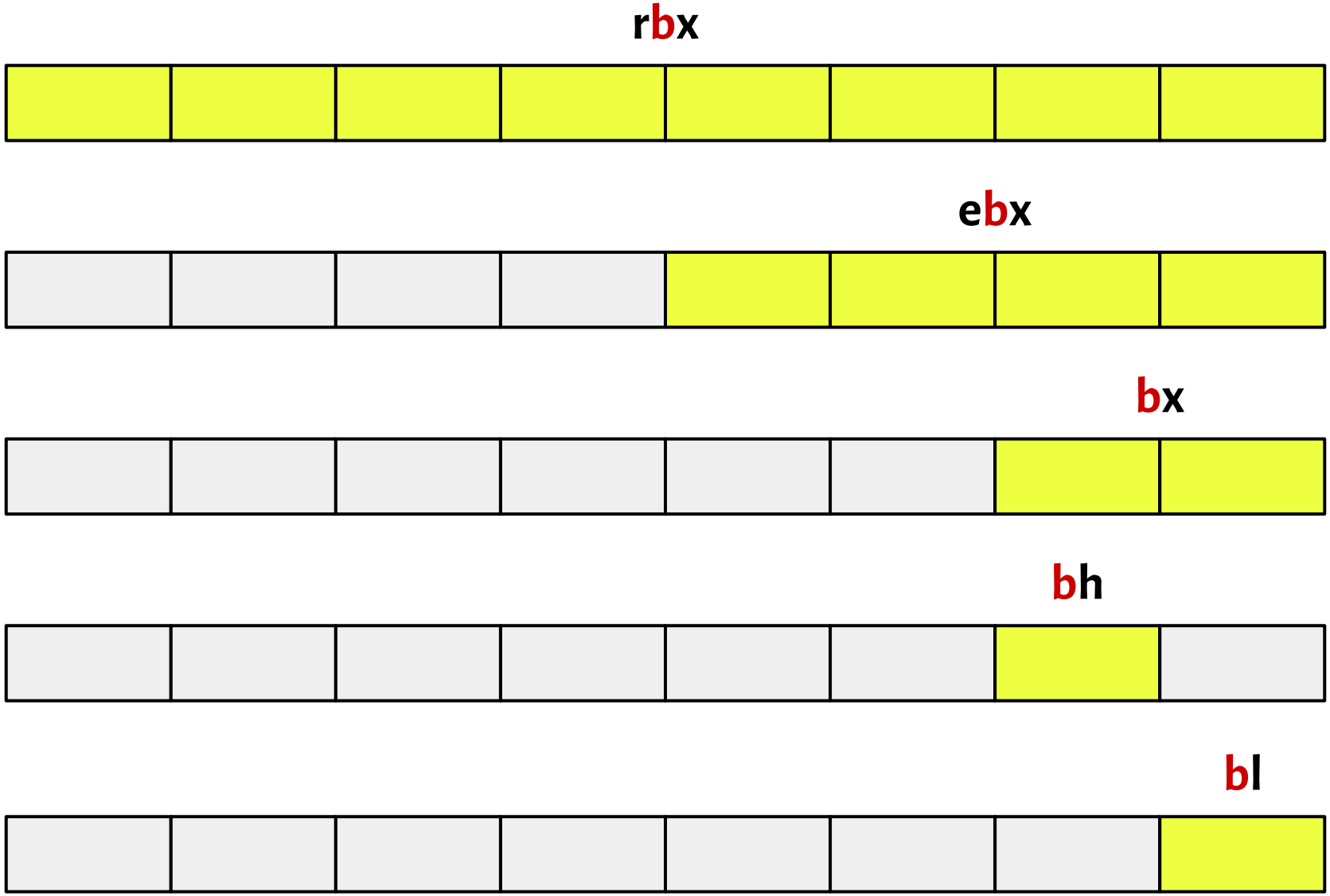
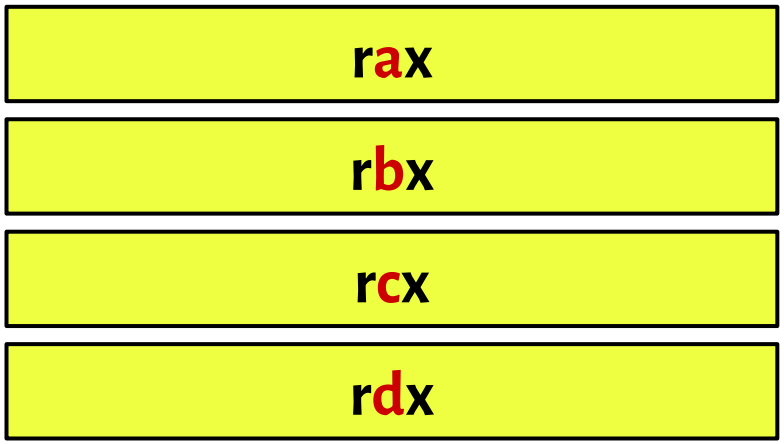


General Purpose Registers

In **x86-64** architecture: 16 General Purpose Registers



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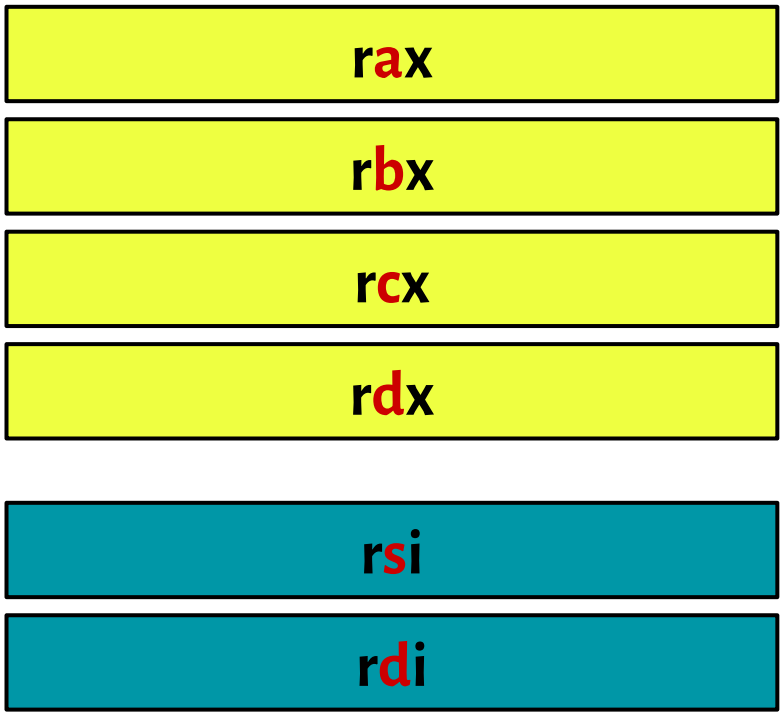

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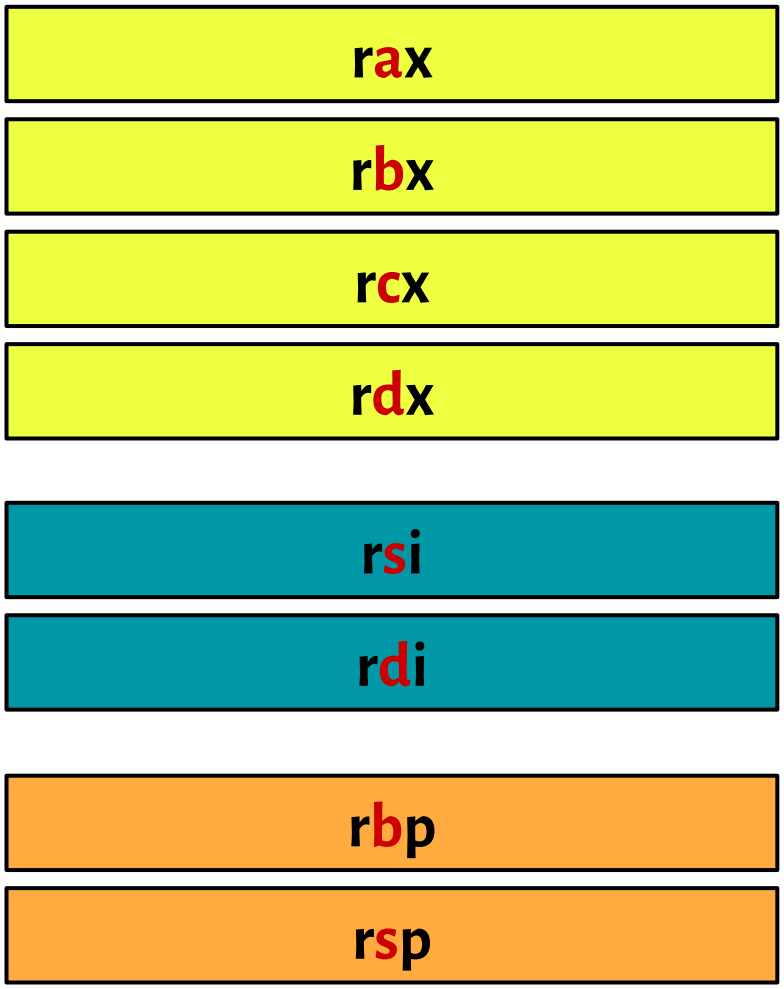

General Purpose Registers

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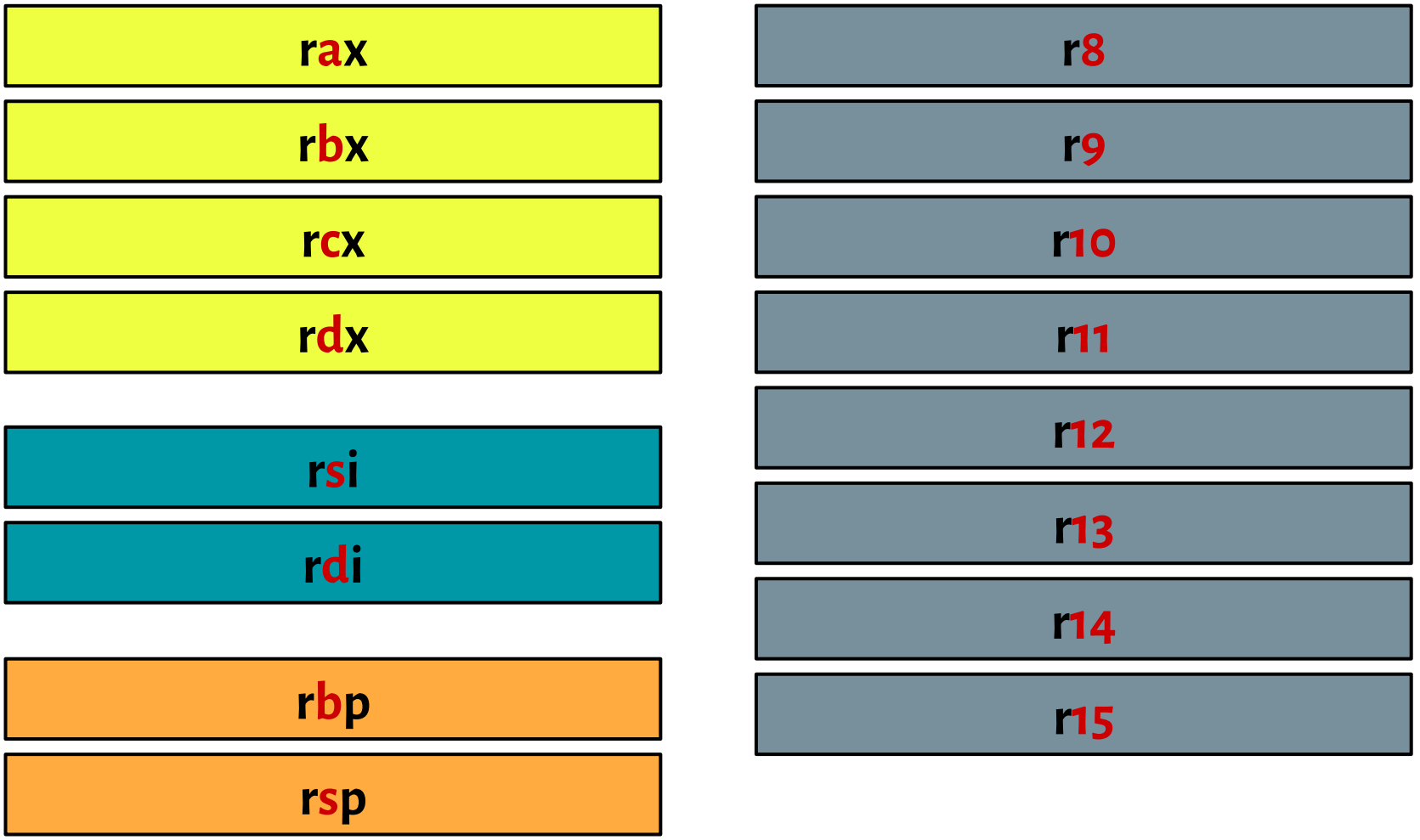


Other Registers

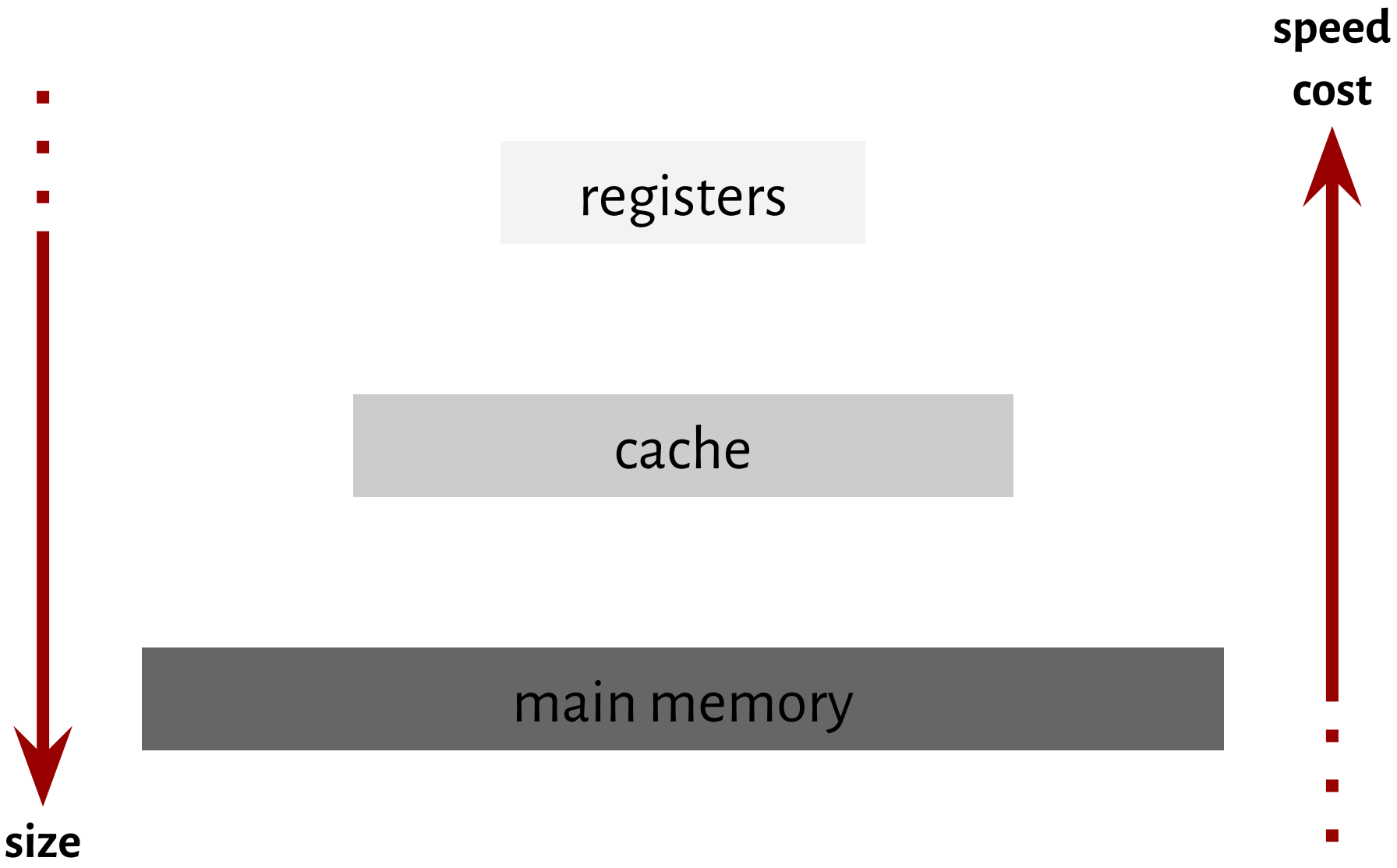
Instruction Pointer Register (rip)

Flag Registers (rFlags)

XMM registers

and other other…

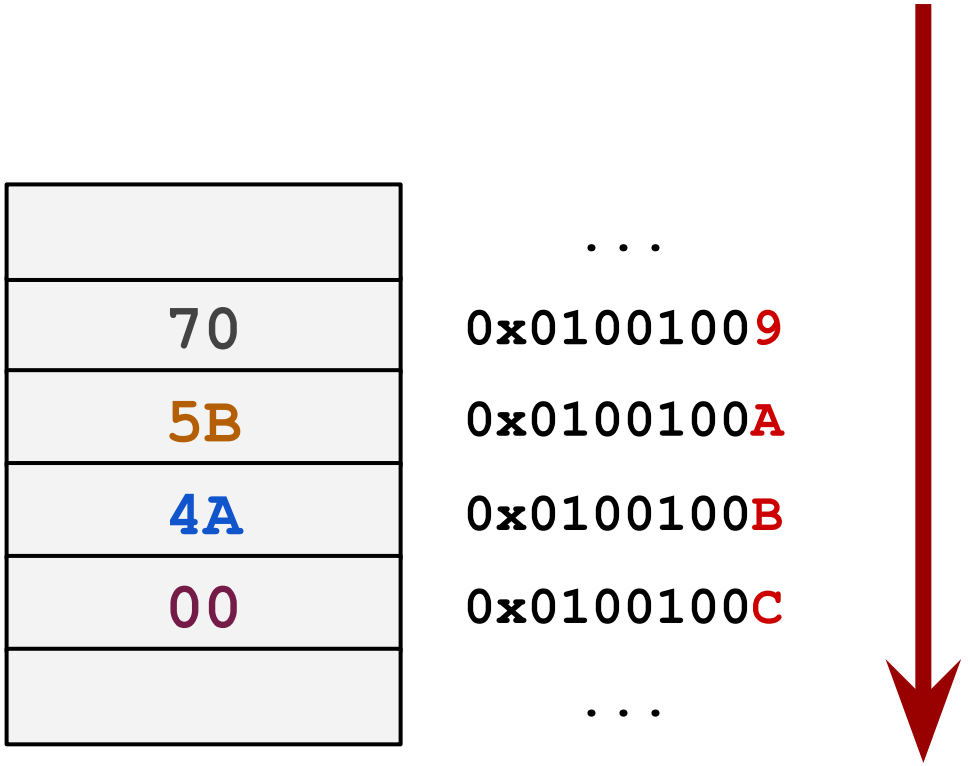
Memory hierarchy



Main Memory

Main Memory

each memory address specifies a corresponding **byte**



Main Memory

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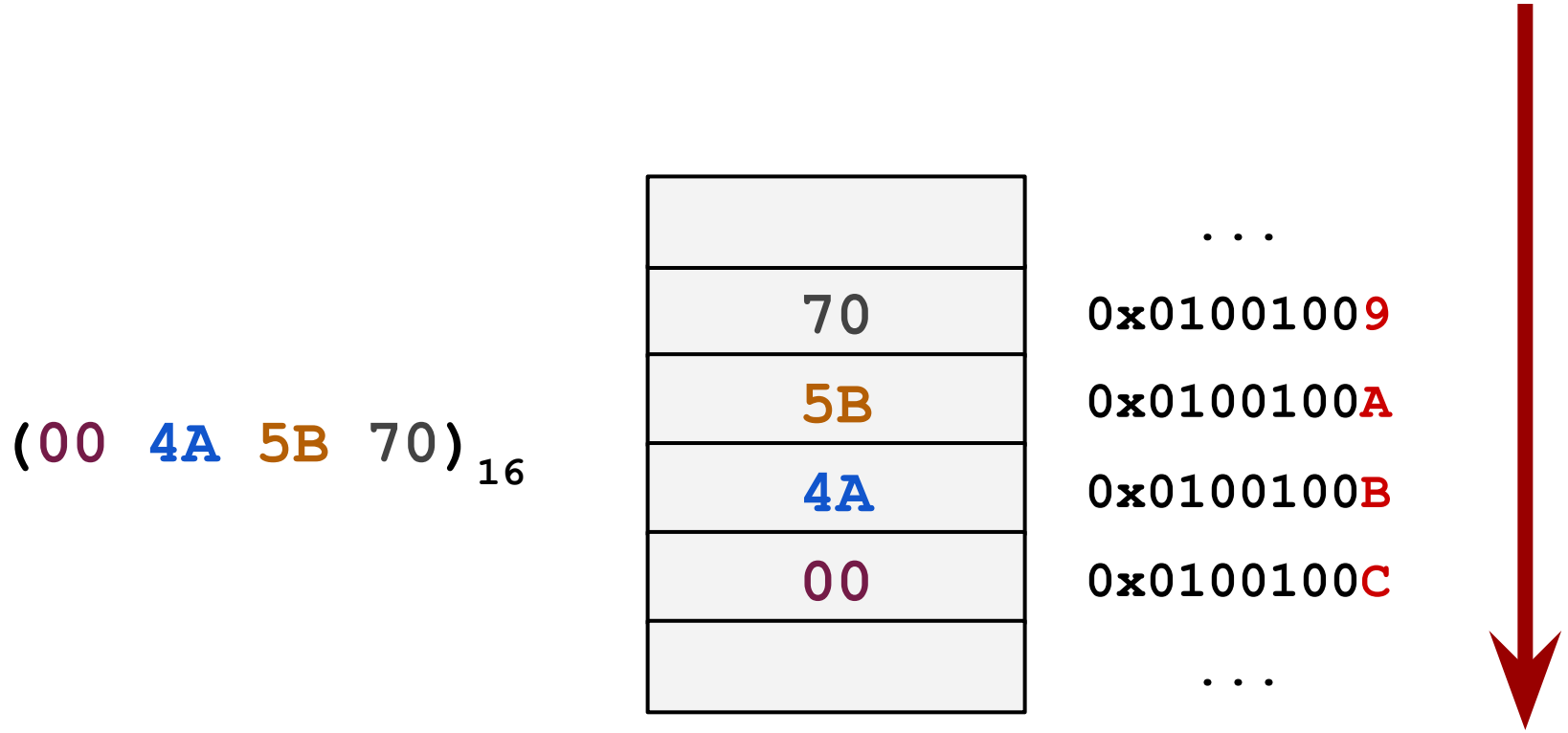
little-endian: little end goes first



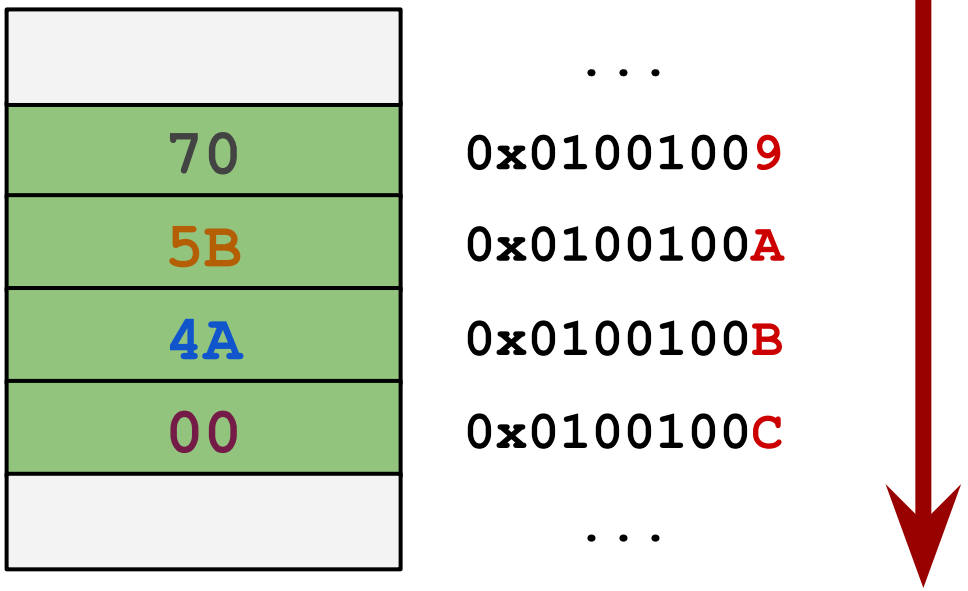
Main Memory

each memory address specifies a corresponding **byte**

little-endian: little end goes first

a computer accesses memory by a single **memory word** at a time

$(00\ 4A\ 5B\ 70)_{16}$



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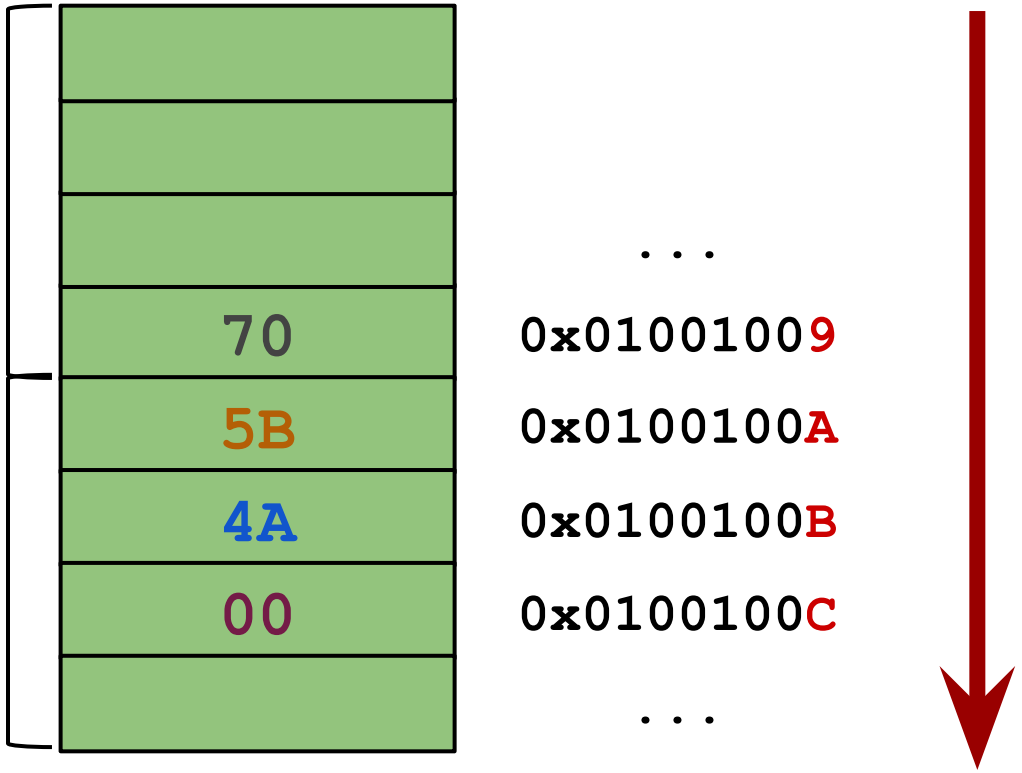
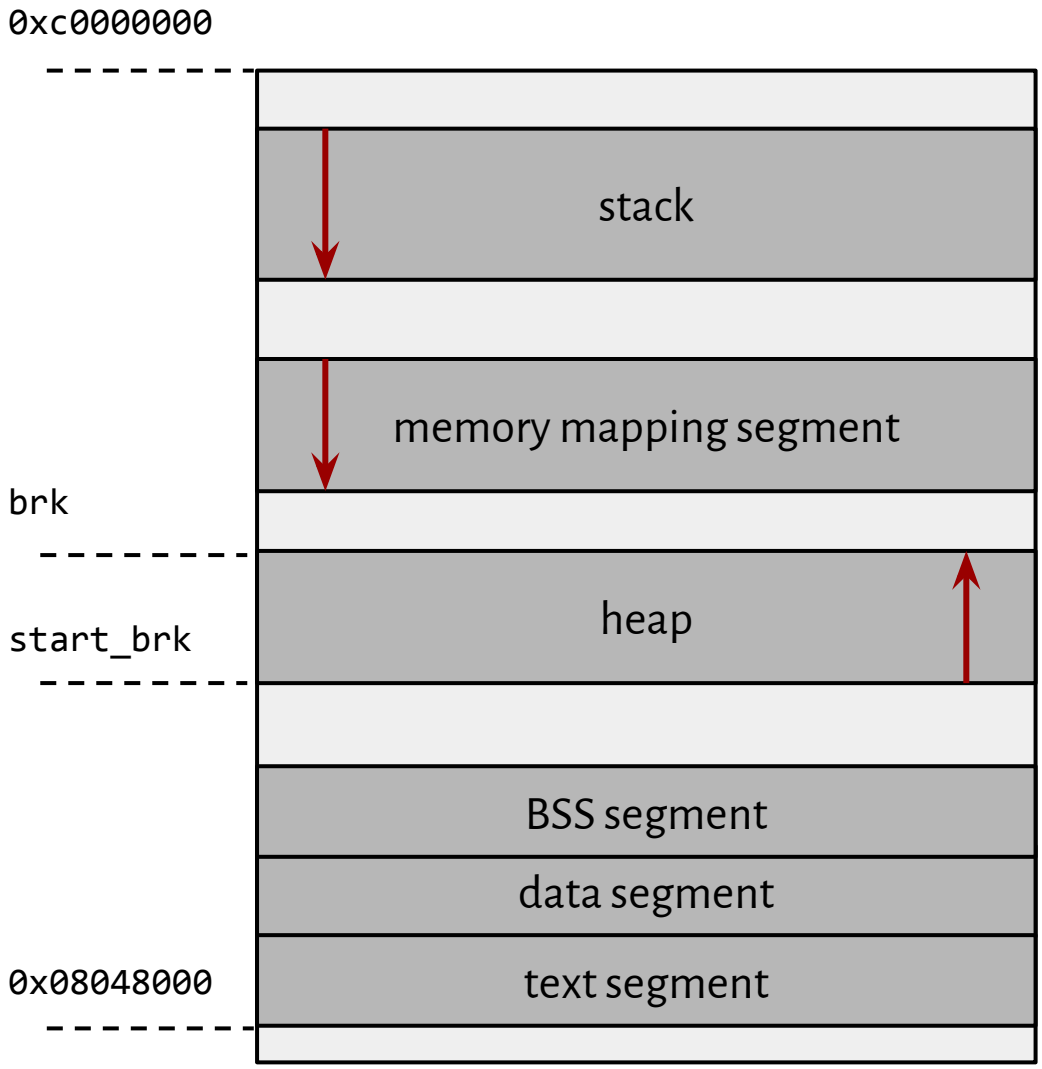
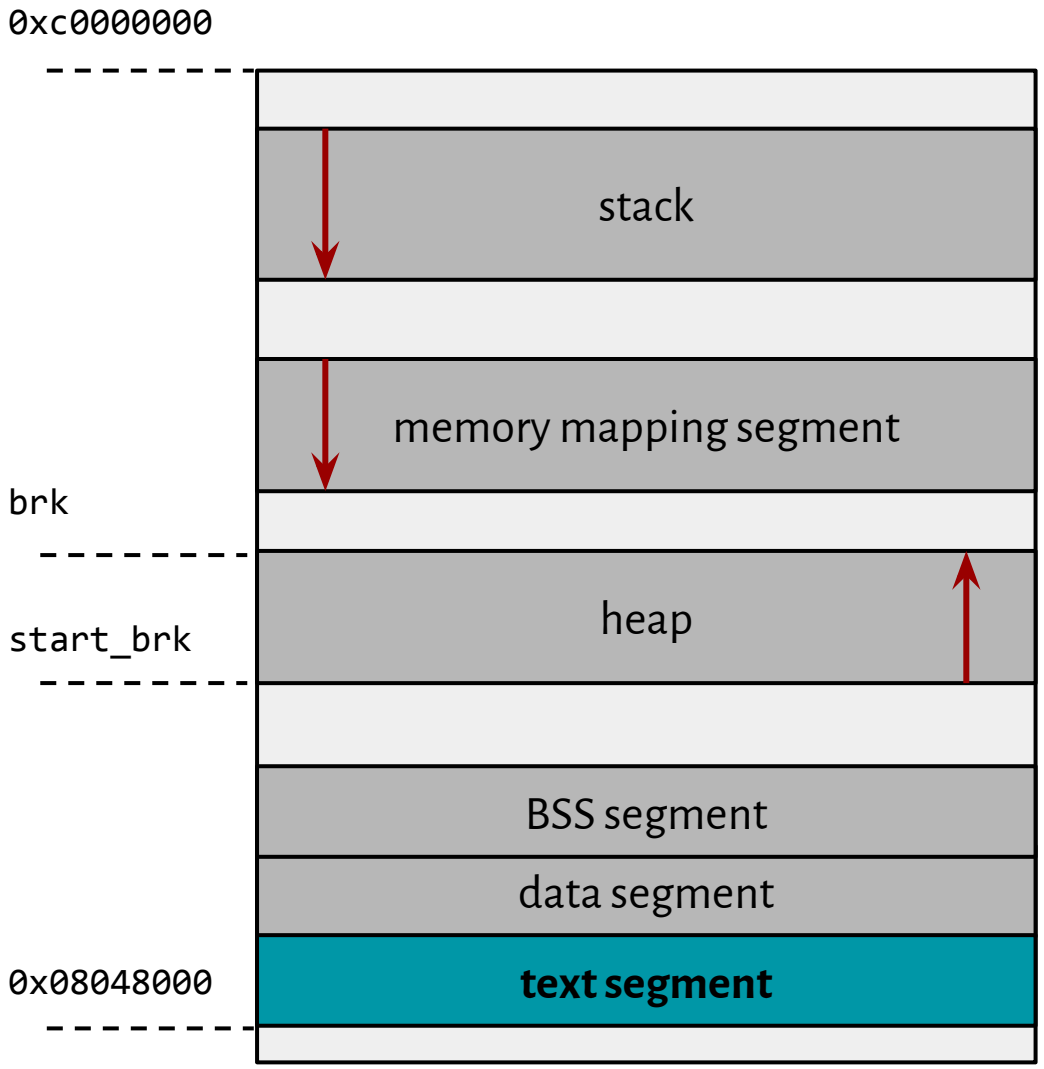


Program Memory Layout



Program Memory Layout

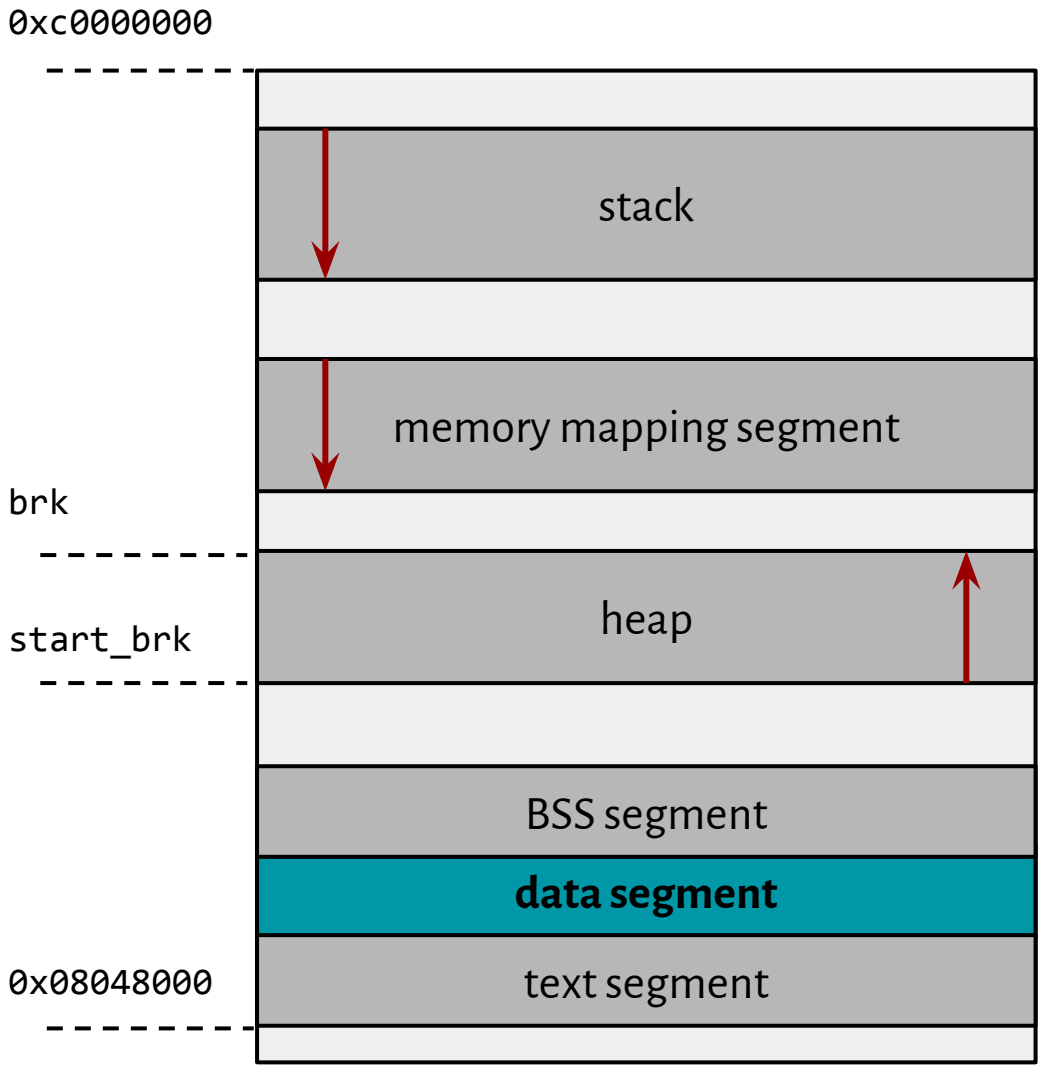


text segment (code segment)

corresponds to a part of an object file and contains executable instructions

- ★ read-only
- ★ fixed size

Program Memory Layout

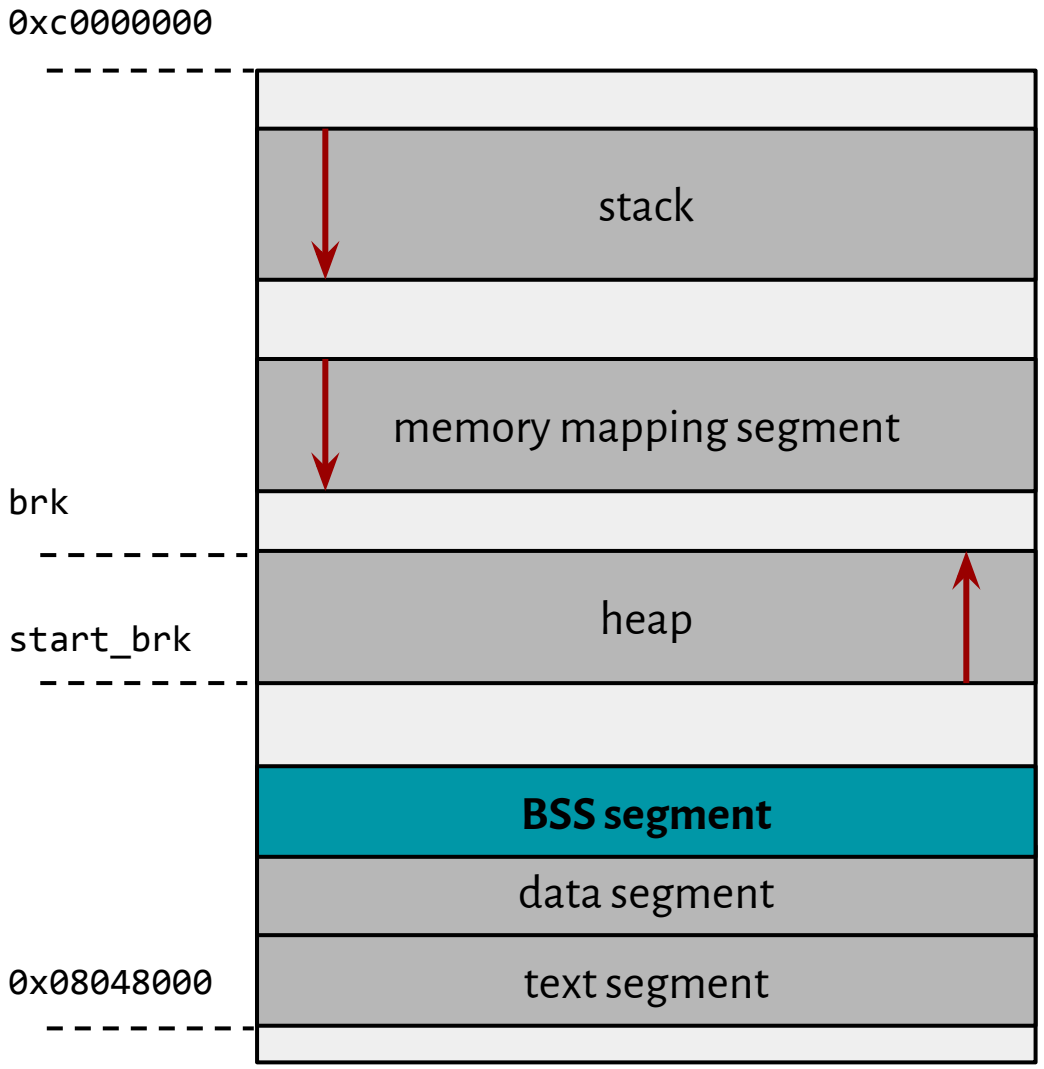


data segment

contains any global or static variables which have a predefined value and can be modified

- ★ read-write
- ★ fixed size

Program Memory Layout

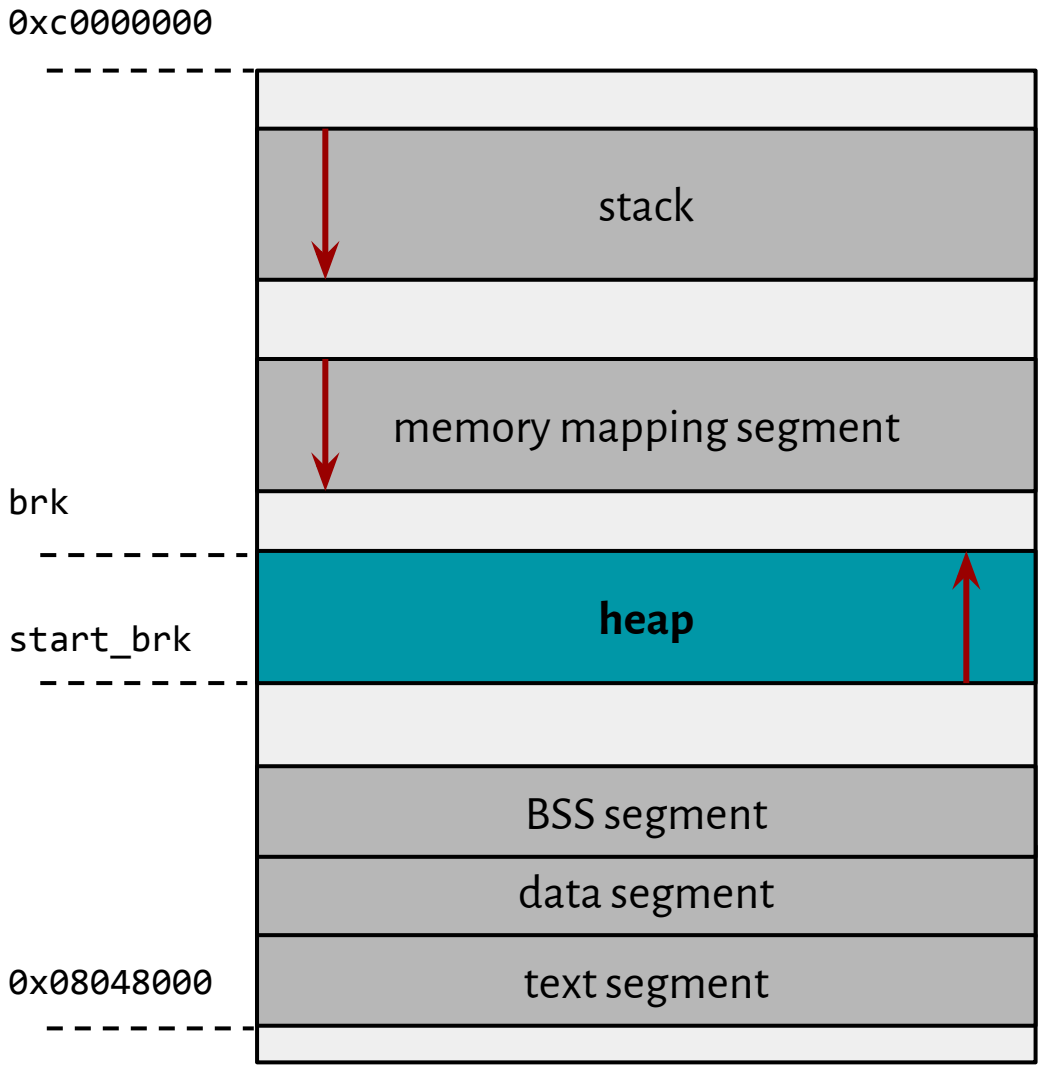


BSS segment

memory initialized with zeroes that represent uninitialized static variables

- ★ read-write
- ★ fixed size

Program Memory Layout

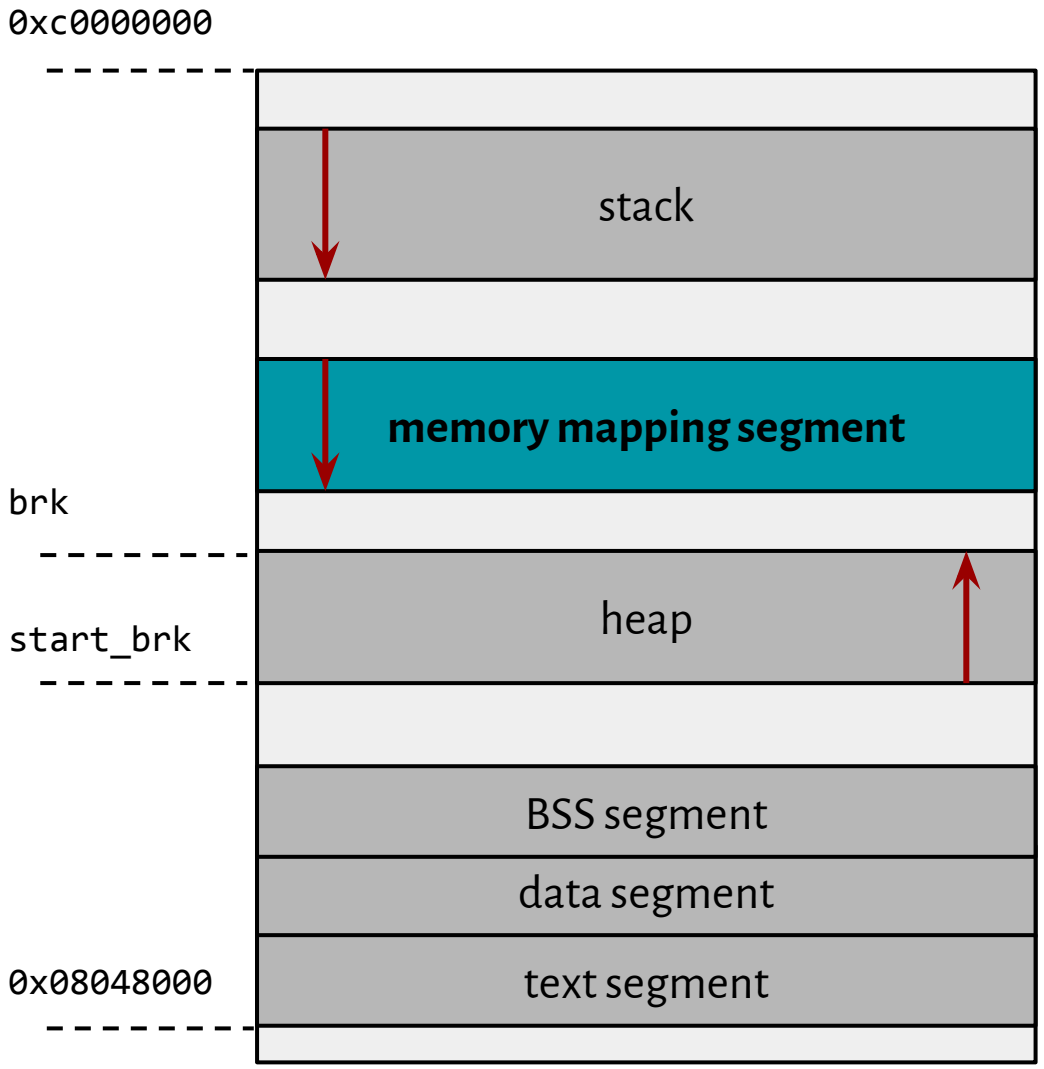


heap

contains the dynamically allocated memory

- ★ read-write
- ★ dynamic size

Program Memory Layout

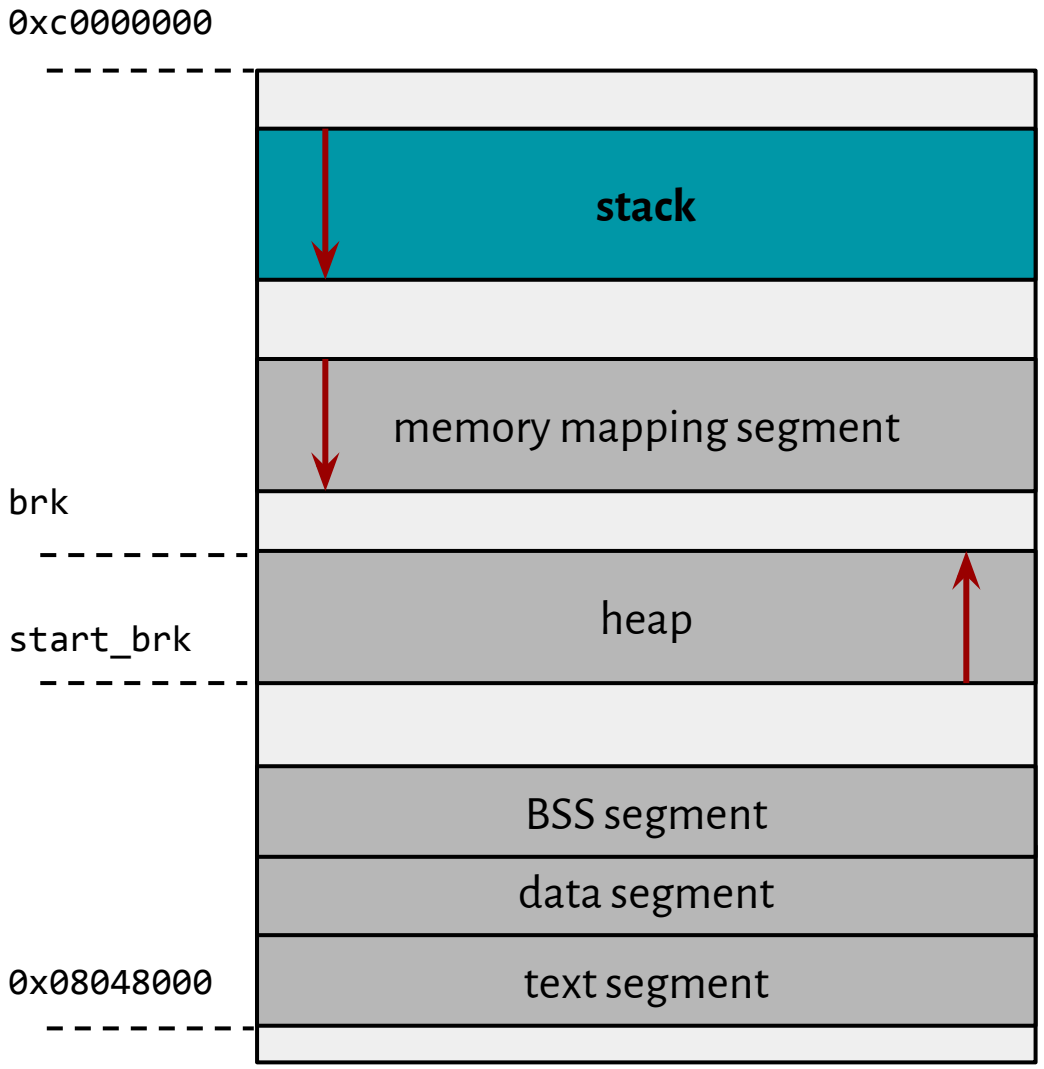


mmap segment

a direct byte-for-byte correlation with some portion of a file or file-like resource

- ★ read-write
- ★ dynamic size

Program Memory Layout

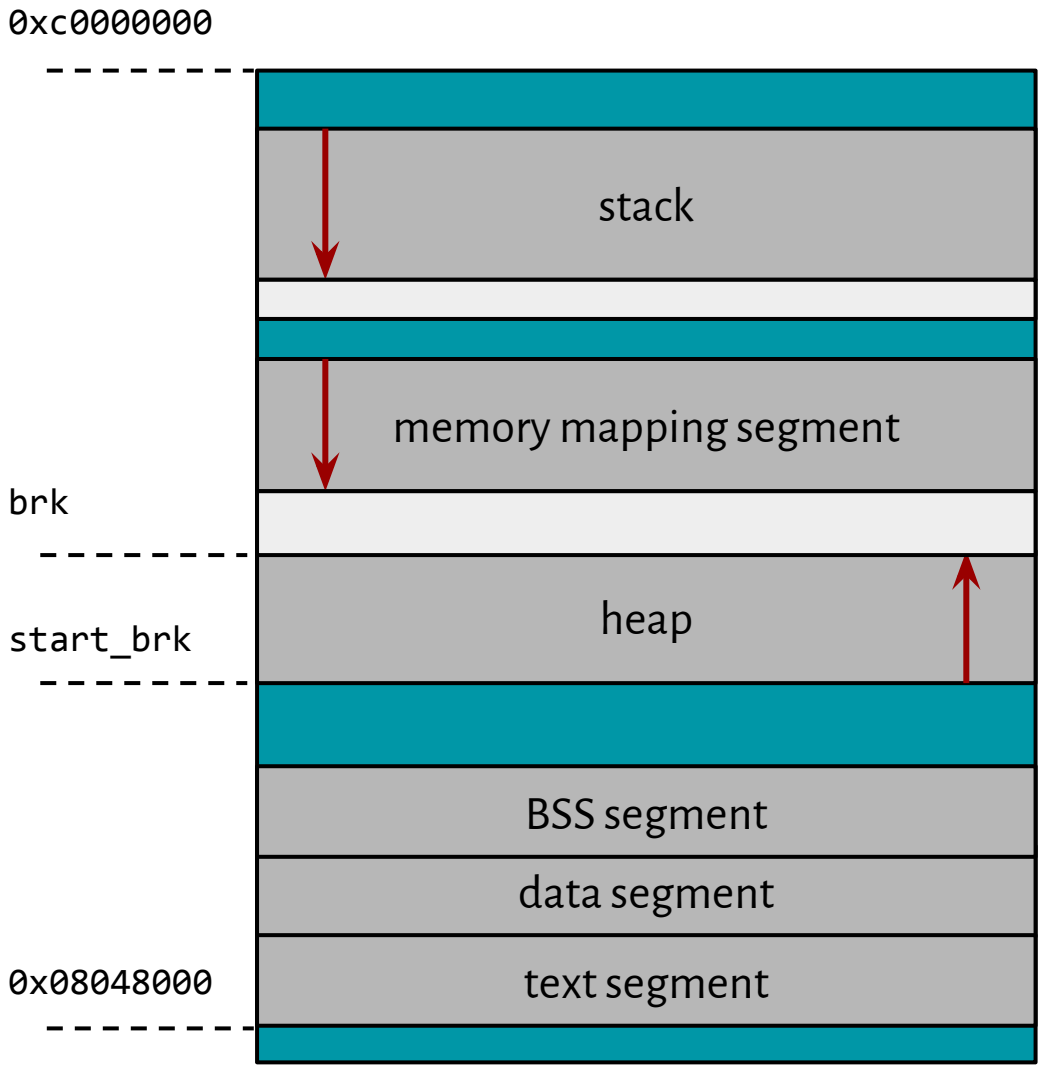


stack

stores local variables and function parameters

- ★ read-write
- ★ dynamic size

Program Memory Layout



offsets

present because of safety reasons

★ any access triggers a segfault

★ dynamic size (random)

Assembly language

★ one-to-one correspondence:

assembly instruction  machine code instruction

Assembly language

★ one-to-one correspondence:

assembly instruction ⟷ machine code instruction

★ specific to a particular computer architecture

Assembly language

★ one-to-one correspondence:

assembly instruction ⟷ machine code instruction

★ specific to a particular computer architecture

★ x86 assembly language has two main syntax branches

```
mov $5, %eax
```

AT&T

```
mov eax, 5
```

Intel

Assembly - basic instructions

```
registers_and_memory:
        mov ebp, esp
        mov rax, qword [mloc]
        mov [mloc], ecx
registers_and_stack:
        pop eax
        push ebx
```

Assembly - basic instructions

```
arithmetic_operations:
        add eax, ebx
        add rax, qword [mloc]
        or <dest>, <src>
```

https://c9x.me/x86/html/file_module_x86_id_5.html

Assembly - basic instructions

Add

Opcode	Mnemonic	Description
04 ib	ADD AL, imm8	Add imm8 to AL
05 iw	ADD AX, imm16	Add imm16 to AX
05 id	ADD EAX, imm32	Add imm32 to EAX
80 /0 ib	ADD r/m8, imm8	Add imm8 to r/m8
81 /0 iw	ADD r/m16, imm16	Add imm16 to r/m16
81 /0 id	ADD r/m32, imm32	Add imm32 to r/m32
83 /0 ib	ADD r/m16, imm8	Add sign-extended imm8 to r/m16
83 /0 ib	ADD r/m32, imm8	Add sign-extended imm8 to r/m32
00 /r	ADD r/m8, r8	Add r8 to r/m8
01 /r	ADD r/m16, r16	Add r16 to r/m16
01 /r	ADD r/m32, r32	Add r32 to r/m32
02 /r	ADD r8, r/m8	Add r/m8 to r8
03 /r	ADD r16, r/m16	Add r/m16 to r16
03 /r	ADD r32, r/m32	Add r/m32 to r32

Description

Adds the first operand (destination operand) and the second operand (source operand) and stores the result in the destination operand. The destination operand can be a register or a memory location; the source operand can be an immediate, a register, or a memory location. (However, two memory operands cannot be used in one instruction.) When an immediate value is used as an operand, it is sign-extended to the length of the destination operand format.

The ADD instruction performs integer addition. It evaluates the result for both signed and unsigned integer operands and sets the OF and CF flags to indicate a carry (overflow) in the signed or unsigned result, respectively. The SF flag indicates the sign of the signed result.

This instruction can be used with a LOCK prefix to allow the instruction to be executed atomically.

https://c9x.me/x86/html/file_module_x86_id_5.html

Assembly - basic instructions

Add

Opcode	Mnemonic
04 ib	ADD AL, imm8
05 iw	ADD AX, imm16
05 id	ADD EAX, imm32
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81 /0 id	ADD r/m32, imm32
83 /0 ib	ADD r/m16, imm8
83 /0 ib	ADD r/m32, imm8
00 /r	ADD r/m8, r8
01 /r	ADD r/m16, r16
01 /r	ADD r/m32, r32
02 /r	ADD r8, r/m8
03 /r	ADD r16, r/m16
03 /r	ADD r32, r/m32

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n operand format.
and CF flags to indicate

Mnemonic
ADD AL, imm8
ADD AX, imm16
ADD EAX, imm32
ADD r/m8, imm8
ADD r/m16, imm16
ADD r/m32, imm32
ADD r/m16, imm8
ADD r/m32, imm8
ADD r/m8, r8
ADD r/m16, r16
ADD r/m32, r32
ADD r8, r/m8
ADD r16, r/m16
ADD r32, r/m32

https://c9x.me/x86/html/file_module_x86_id_5.html

Assembly - basic instructions

```
arithmetic_operations:
        add eax, ebx
        add rax, qword [mloc]
        or <dest>, <src>
registers_and_stack:
        jmp eax
        cmp rcx, 0
        jne arithmetic_operations
```

Assembler


```
$ nasm -f elf program.asm
```


```
$ ld -o program program.o
```

Zadanie 1

Dana jest ścieżka do pliku binarnego, który zawiera sekwencję 32-bitowych liczb zapisanych w formacie big-endian.

Otwórz plik i sprawdź, czy:

- ★ nie zawiera liczby 68020,
- ★ zawiera liczbę większą od 68020 i mniejszą od 2^{31},
- ★ zawiera kolejno pięć liczb: 6, 8, 0, 2 i 0,
- ★ suma wszystkich liczb mod 2^{32} jest równa 68020.

Jeśli warunki są spełnione: zakończ z wynikiem 0.
W przeciwnym razie: zakończ z wynikiem 1.

Zadanie 1

★ Jak sprawdzić liczbę argumentów podanych do programu?

Ich liczba jest na stosie, podobnie jak nazwa (szczegóły: ABI).

★ Jak odpowiednio zakończyć program?

```
mov rax, 60       ; numer wywołania systemowego exit
mov rdi, 0
syscall
```

★ Jak odczytać zawartość pliku binarnego?

```
$ od -tx4 -i --endian=big _test_1.0
```

A scheme of an assembly program

```
global _start

SYS_EXIT  equ 60

section .rodata

section .bss

section .text

exit_error:
  mov     rax, SYS_EXIT
  mov     rdi, 1
  syscall

exit_ok:
  mov     rax, SYS_EXIT
  xor     rdi, rdi
  syscall
```

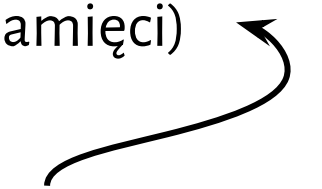
```
_start:
  cmp     qword [rsp], 2
  jne     exit_error
  mov     rdi, [rsp + 16]
  call    open_file
  jmp exit_ok

open_file:
  ret
```

Zadanie 1

Co jest oceniane?

- ★ poprawność
- ★ czas działania programu
- ★ zapotrzebowanie na pamięć
- ★ rozmiar kodu maszynowego (sekcje ładowalne w pamięci)
- ★ jakość kodu źródłowego
- ★ spełnienie formalnych wymagań



Place your code in the repo.

Zadanie 1

Put your solution into the repository before:

22 March 2018, 8 p.m.

But first, make sure you can access your repository account:

```
$ svn checkout https://svn.mimuw.edu.pl/repos/SO/studenci/ab123456
$ cd ab123456
$ mkdir zadanie1
$ svn add zadanie1
$ svn commit -m "zalozenie katalogu na rozwiazanie pierwszego zadania"
```